PATENT SPECIFICATION 935,884

DRAWINGS ATTACHED.

935,884

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International Classification :—B64c.

COMPLETE SPECIFICATION.

Improved Flying Vehicle.

We, FORD MOTOR COMPANY LIMITED, of 88 Regent Street, London, W.1, a Company incorporated under the laws of Great Britain, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to ducted fan flying vehicles which are capable of controlled vertical ascent and of controlled vertical descent relative to the ground with inherent stability in flight.

Currently, great difficulties are encountered in maintaining the stability of an airborne ducted fan flying vehicle especially when close to the ground, since any upsetting of the balanced forces acting on the vehicle will create a moment about the vehicle's centre of gravity tending to cause it to capsize.

The invention consists in a vehicle capable of vertical ascent from the ground and vertical descent to the ground comprising a fuselage having a plurality of power driven ducted fans including, lifting rotors generating vertical lifting forces along their respective axes of rotation, the axis of each of the plurality of lifting rotors being arranged so that the forces generated by such rotors resolve into a single vertical force component acting substantially along a vertical axis passing through the centre of gravity of said vehicle, the axis of rotation of each of these lifting rotors being arranged so that the horizontal distance between each lifting rotor's axis of rotation and the vertical axis of the vehicle becomes greater as these axes are extended below the vehicle.

A preferred ducted fan flying vehicle embodying the present invention has a plurality of power driven lifting rotors mounted in its fuselage. The lifting rotors are arranged so that the lifting forces generated by the rotors along their respective axes of rotation resolve into a single vertical component acting along the vehicle vertical axis. The vertical axis of the vehicle as applied in this invention is defined as the "the axis which passed through the centre of gravity and is normal to the horizontal longitudinal and transverse axes of the ducted fan flying vehicle".

In the various embodiments of this invention, all the rotating axes of the power driven lifting rotors are arranged to approach each other when extended above the vehicle, or, conversely stated, the horizontal distances between the axis of each lifting rotor and the vertical axis passing through the centre of gravity of the ducted fan flying vehicle becomes greater as the axes are extended below such a vehicle.

In each embodiment, the algebraic sum of the horizontal components of the lifting forces developed by the rotors is to be equal to zero to maintain the stability of the vehicle.

The present invention will be further described with reference to the accompanying drawings where like numerals are applied to like parts in the several views, and wherein:—

Figure 1 is a diagrammatic perspective view of one embodiment of the ducted fan flying vehicle of this invention depicting schematically the various forces acting on the vehicle;

Figure 2 is a perspective view of a ducted fan flying vehicle equipped with three power driven lifting rotors; and

Figure 3 is a perspective view of a further embodiment of this invention depicting a ducted fan flying vehicle which is equipped with four power driven lifting rotors.

[*Price* 4*s.* 6*d.*]

As shown in Figure 1, a lifting force is developed by each rotor 11 along its axis of rotation 12. The rotors 11 are mounted in the fuselage 13 of a ducted fan flying vehicle 14 so that their axes of rotation make a slight angle with the vertical plane.

The rotors 11 in the forward portion of the fuselage 13 are arranged so that the lines of action of the vertical lifting forces F_{f1} and F_{f2} respectively, of each forward rotor 11 intersect at a point R_f above the vehicle 14. The rotors 11 in the rearward portion of the fuselage 13 are arranged so that the lines of action of the vertical lifting forces F_{r1} and F_{r2} respectively, of each rearward rotor intersect at a point R above the vehicle 14. The lines of action of the resultant lifting force F_{tr} of the rotor 11 located in the rearward portion of the fuselage 13 and the resultant lifting force F_{tf} of the rotors 11 located in the forward portion of the fuselage 13 intersect at a point R_t, which is located above the points R_r and R_f. The resultant lifting forces F_{tr} and F_{tf} resolve into a single vertical lifting component F_{vt} on the vertical axis L_v of the vehicle 14. The vertical axis L_v of the vehicle passes through the centre of gravity CG of the vehicle and is to be normal to the horizontal longitudinal axis L_l and the transverse axis L_t of the vehicle 14.

The vertical component of the lifting forces F_{vt} causes the vehicle 14 to ascend when this component force F_{vt} exceeds the weight F_v of the vehicle 14 acting at the centre of gravity CG.

The algebraic sum of the horizontal components F_{htf} and F_{htr} of the resulting lifting forces F_{tr} and F_{tf} must be equal to zero if the point of resolution R_t is to lie on the vertical axis L of the vehicle 14.

The point of resolution R_t may lie any desired distance above the centre of gravity CG of the vehicle 14.

Any number of lifting rotors 11 may be used as long as all lifting forces resolve into a single vertical component acting at a point above the vehicle 14 and as long as this point lies on the verical axis L_v of the vehicle 14 which passes through the centre of gravity CG of the vehicle and is normal to its horizontal longitudinal axis L_l and to its horizontal transverse axis L_t.

In Figure 2 is seen the fuselage 13 of the flying vehicle 14 illustrating a second embodiment of this invention. The flying vehicle 14 has a control cabin 15 near its centre and a plurality of lifting rotors 11 mounted in ducts 16 which extend through the fuselage 13 of the vehicle 14. Each lifting rotor 11 is mounted on a shaft 17 lying on the axis of rotation 12 of the rotor 11. This shaft 17 may be driven by individual power plants or through a mechanical drive connection from a central power plant (not shown in the accompanying drawings) elsewhere in the vehicle 14. Wheels 18 extending from the fuselage 13 provide for movement of the vehicle 14 on the ground. The vehicle 14 may be propelled on the ground or in the air in a horizontal direction, if so desired, by any known method such as independent propellers. The horizontal propulsion mechanisms form no part of this invention and therefore have not been illustrated.

In this embodiment, the flying vehicle 14 is equipped with three power driven lifting rotors 11. One of said rotors 11 is located in the forward portion of the fuselage 13 and the remaining two rotors 11 are located in the rearward portion of the fuselage 13. The axis 12 of the front rotor 11 intersects with the axes 12 of the rear rotors at a common point 19 above the vehicle which lies on the vertical axis 20 of the vehicle which passes through the centre of gravity of the vehicle 14 and is normal to its horizontal transverse axis 21 and to its horizontal longitudinal axis 22.

In Figure 3 is seen a second embodiment of this invention illustrating one arrangement for mounting four lifting rotors 11 in a fuselage 13 of the flying ducted fan vehicle 14. Two of the power driven lifting rotors 11 are located in the forward portion of the fuselage 13 and the remaining two power driven lifting rotors 11 are located in the rearward portion of the fuselage 13. The axes of rotation 12 of the two rotors 11 in the forward portion intersect with the axes of rotation 12 of the two rotors 11 in the rearward portion at a common point 23 above the vehicle 14. This point of intersection 23 lies on the vertical axis 20 of the vehicle which passes through the centre of gravity of the vehicle and is normal to its horizontal transverse axis 21 and to its horizontal longitudial axis 22. Since the rotors 11 are only slightly inclined with respect to the horizontal plane, the common point of intersection 23 of the axes of rotation 12 of the forward and rearward rotors 11 is located at a substantial distance above the vehicle 14.

It is to be understood that in accordance with the principles of this invention as illustrated in Figure 1, the axes 12 of the rotors 11 located in the rearward portion of the fuselage 13 in the second embodiment of this invention as illustrated in Figure 2 and the vertical axes of the two rearward rotors and the two forward rotors in the third embodiment as illustrated in Figure 3 may intersect at any point above the vehicle. The line of action of the resultant forces from the respective points of intersection are to intersect with the line of action of any other direct vertical lifting force or

resultant lifting forces at a point which is to lie on the vertical axis 20 of the vehicle 14 so that all lifting forces resolve into a single vertical component lying on the vertical axis 20 of such vehicle 14.

In any event, the lifting rotors 11 are to be arranged so that the horizontal components are symmetrical with respect to the horizontal transverse and longitudinal axes of the vehicle 14 to ensure proper balance of the ducted fan flying vehicle 14.

WHAT WE CLAIM IS:—

1. A vehicle capable of vertical ascent from the ground and vertical descent to the ground comprising a fuselage having a plurality of power driven ducted fans including, lifting rotors generating vertical lifting forces along their respective axes of rotation, the axis of each of the plurality of lifting rotors being arranged so that the forces generated by such rotors resolve into a single vertical force component acting substantially along a vertical axis passing through the centre of gravity of said vehicle, the axis of rotation of each of these lifting rotors being arranged so that the horizontal distance between each lifting rotor's axis of rotation and the vertical axis of the vehicle becomes greater as these axes are extended below the vehicle.

2. A vehicle as claimed in Claim 1 in which at least two of these rotors are located remote from both the longitudinal and transverse axes of said vehicle.

3. A vehicle as claimed in Claim 2 comprising four power driven lifting rotors arranged symmetrically with regards to the vehicle.

4. A vehicle as claimed in Claim 3, in which the rotors are arranged on the vehicle so that the axes of rotation of each of these lifting rotors intersect at a common point above said vehicle and on the vertical axis of the vehicle.

5. A vehicle as claimed in Claim 2, comprising three power driven lifting rotors, two of said rotors being located remote from both the horizontal longitudinal and transverse axes of said vehicle so that their axes of rotation intersect at a first point above said vehicle, the time of action of the resultant force of the lifting forces of the two last mentioned rotors intersecting at a second point with the line of action of the lifting force of the remaining rotor, said second point lying above the first point and on the vertical axis of said vehicle.

6. A vehicle as claimed in Claim 3, in which two of said rotors are located in the forward portion of said fuselage and two are located in the rearward portion of said fuselage, the axes of rotation of the lifting rotors located in the forward portion of said fuselage intersecting at a first point above said vehicle, and the axes of rotation of the lifting rotors located in the rearward portion of said fuselage intersectiing at a second point above said vehicle, the line of action of the resultant force of the lifting forces of the forward rotors intersecting at a third point with the line of action of the resultant force of the lifting forces of the rearward rotors, said third point lying above the first and second points and also lying on said vertical axis of said vehicle.

7. A ducted fan flying vehicle substantially as herebefore described with reference to Figure 1, Figure 2 or Figure 3 of the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Agents for the Applicants.

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935884 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

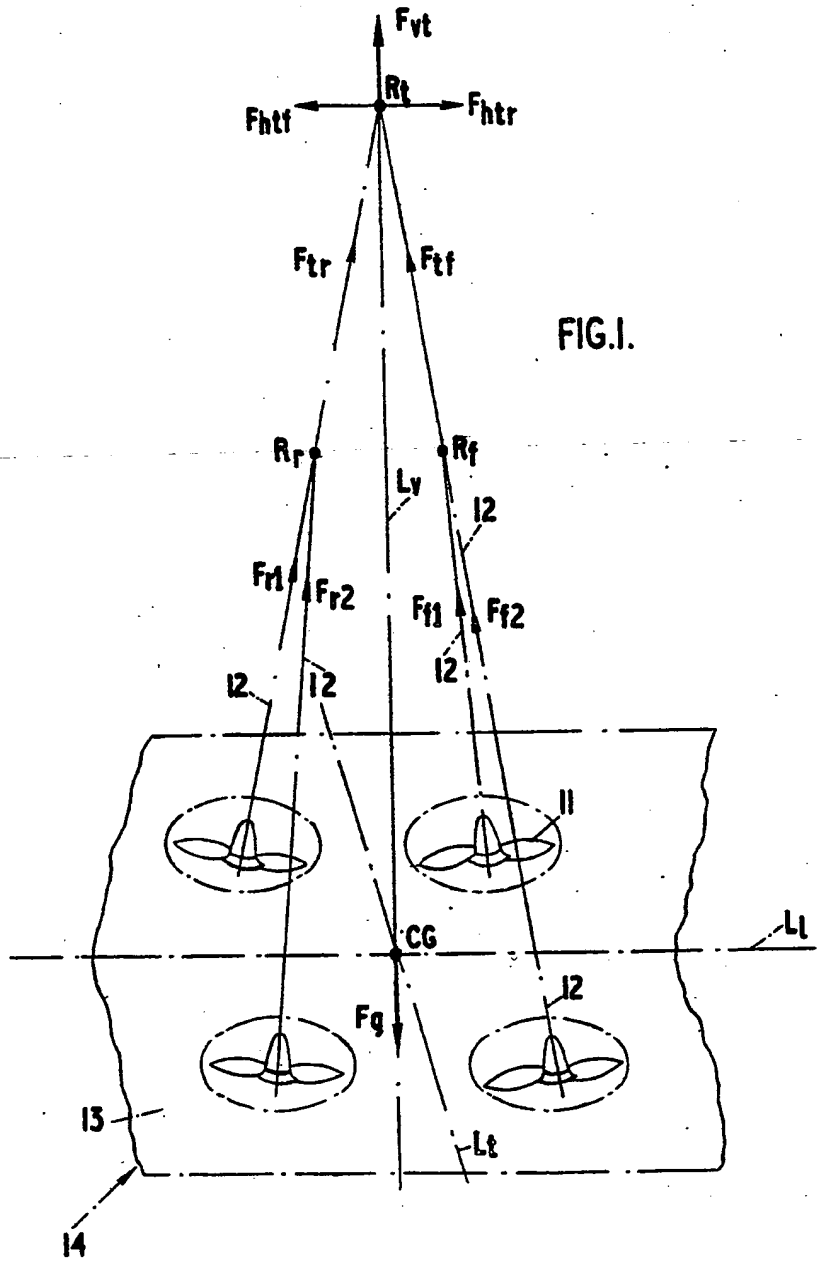

FIG.1.

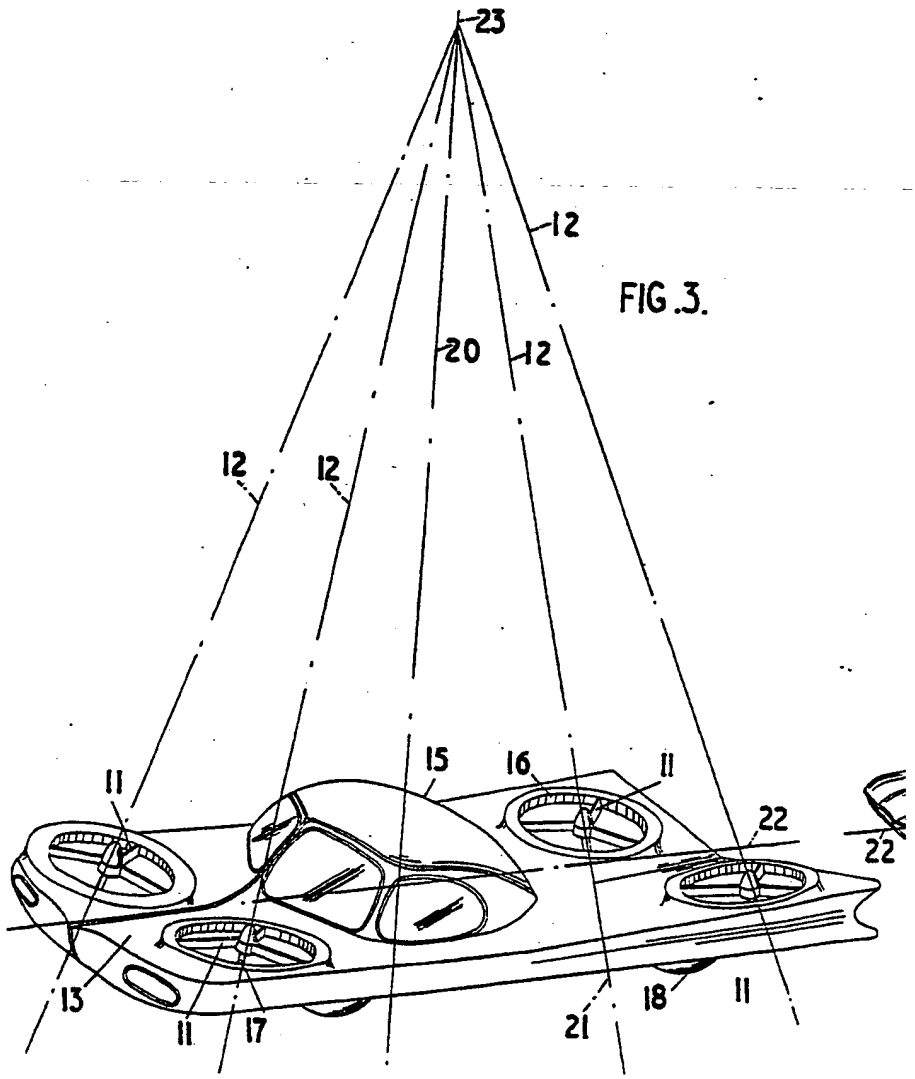

FIG .3.

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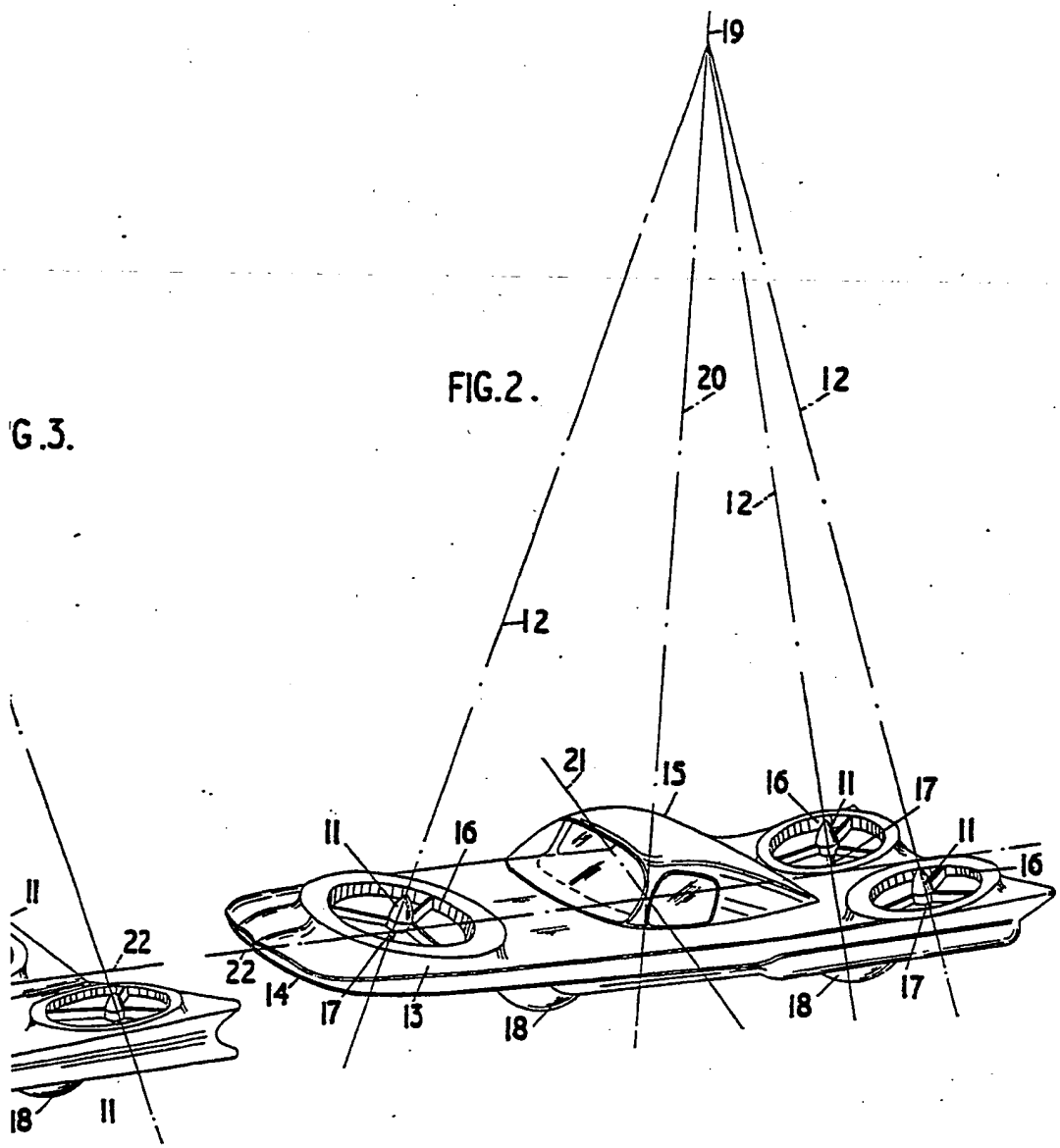
Sheet 2

G.3.

FIG.2.



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Sheet 2

FIG.3.

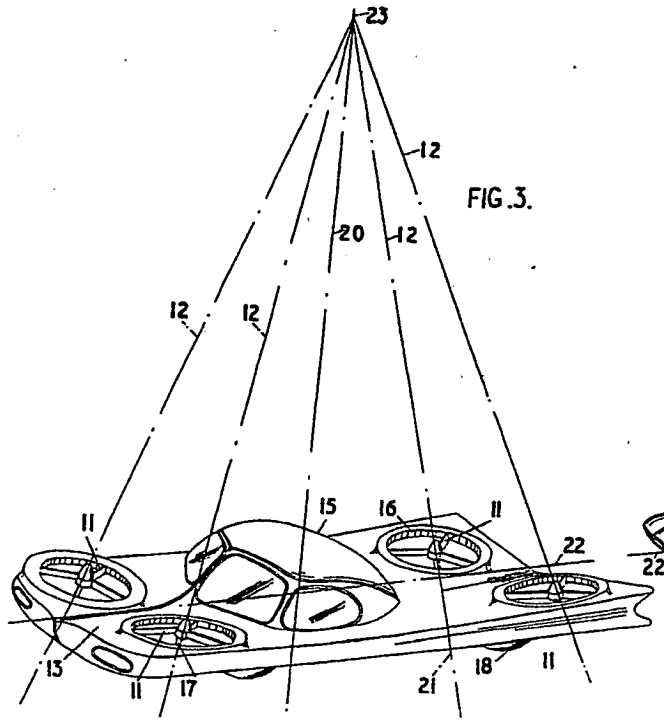

FIG.2.